Practical Lessons in Remote Connectivity

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Community Health Information Networks (CHINs) require the ability to provide computer network connections to many remote sites. During the implementation of the Washington Heights and Inwood Community Health Management Information System (WHICHIS) at the Columbia-Presbyterian Medical Center (CPMC), a number of remote connectivity issues have been encountered. Both technical and non-technical issues were significant during the installation. We developed a work-flow model for this process which may be helpful to any health care institution attempting to provide seamless remote connectivity. This model is presented and implementation lessons are discussed.

INTRODUCTION

Community Health Information Networks (CHINs) are systems that allow the electronic exchange of clinical, financial, and administrative information among unaffiliated health care entities through a combination of services, products, and technology. Their role is to improve the efficiency and delivery of health care in the community.[1]

The concept of CHINs has existed for 20 years but only recently have they become an important technology for health care. They are still in an innovation stage, which implies that the developmental costs often exceed their benefits. A CHIN has five basic characteristics:

- Computer-based information systems and networks are utilized
- Data and information are transferred between organizations
- Data transfer is health related
- Patient specific data is included
- The goal is improved health care delivery.

In the area of Community Health Management Information System (CHMIS) and CHIN research funding, The John A. Hartford Foundation has been a major leader. The Washington Heights-Inwood Community Health Information System (WHICHIS) at the Columbia-Presbyterian Medical Center (CPMC) is one of the demonstration projects funded by the Hartford Foundation. It serves an inner-city community of 240,000 people, two-thirds of whom are of Hispanic heritage. Even though CPMC is the primary provider of hospital services in northern Manhattan, non-affiliated private practice physicians in the community provide about 40% of the total ambulatory care volume. The WHICHIS project seeks to provide a repository for health care information in order to study resource utilization and the costs and outcomes of care[2] and to allow the sharing of administrative, financial, and clinical information between private community practices and CPMC. The goal is to improve clinical care processes and to promote a healthy community by providing data storage, security, and processing services in addition to basic communication services.

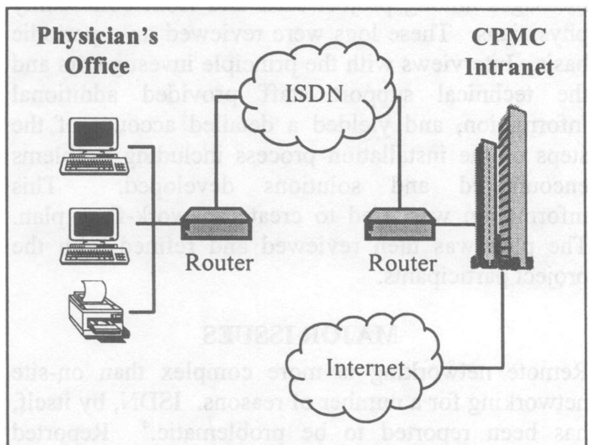

Figure 1 - WHICHIS Architecture

Another WHICHIS goal is to develop an architecture that can provide seamless, yet affordable, networking of the physicians' offices (Figure 1) as opposed to the more common manually initiated dial-up connections. The basic installation in the community physicians' offices includes 2 PCs and a network addressable printer on a Local Area Network (LAN).

Wide-area network (WAN) connectivity with CPMC is provided via Integrated Services Digital Network (ISDN). At each site, an ISDN router dials "on demand" to receiving ISDN lines that are connected to a Basic Rate Interface (BRI) board on a CPMC network router.[2] This provides community physicians with seamless access to the Integrated Advanced Information Management System (IAIMS) resources at CPMC. On-line library resources, electronic mail, clinical patient data, decision support tools, and educational materials are made available over Internet-based communication protocols (TCP/IP, Telnet, WWW).[3] A commercial physician office management system (POMS) is also included at each site. ISDN is able to provide relatively high bandwidth (64-128Kbaud) and the line is only active when information is being transferred. Not only does this have the potential to reduce costs, it also reduces the number of incoming lines required at CPMC.

However, the use of ISDN to provide seamless networking at independent, remote sites has proven especially challenging. This paper will focus on some of the issues encountered and on a work-flow plan that was developed to facilitate efficient installation and maintenance of the remote network. The methods developed in this project are applicable to any health care institution attempting to provide seamless remote connectivity.

METHODS

Part of the project involved maintaining email logs of messages among project staff and from community physicians. These logs were reviewed on a periodic basis. Interviews with the principle investigators and the technical support staff provided additional information, and yielded a detailed account of the steps of the installation process including problems encountered and solutions developed. This information was used to create a work-flow plan. The plan was then reviewed and refined with the project participants.

MAJOR ISSUES

Remote networking is more complex than on-site networking for a number of reasons. ISDN, by itself, has been reported to be problematic.[4] Reported ISDN implementations have involved connections between health care institutions[5] rather than individual physicians. Health care institutions usually have technical support staff available to address problems. In contrast, there is no support staff located at community physicians' offices. Any service requires a separate trip by CPMC support staff. Therefore, the networking configuration at these remote sites requires robustness and stability. Developing a workable configuration initially required several months of experimentation and collaboration with the local phone company (NYNEX).

A desktop computer configuration that supported intra-office LAN connectivity, transparent WAN connectivity, and the required suite of applications (DOS, Windows, X-Windows, WWW) was also a technical challenge. This was not solved until Windows 95 became available late in 1995.

Another major factor encountered was the aging inner-city infrastructure. Many of the buildings in the community were built in the 1920's or before. Sites sometimes required physical upgrades, such as electrical wiring or new cabinetry to accommodate computer hardware in the office space. Since these were independent sites, the community physician's office arranged for these upgrades. Requirements were communicated to the community physician or office personnel, who were then expected to provide these requirements to the contractor. This indirect communication was a source of repeated miscommunication and error.

Providing adequate training was another important issue. Many of the community physicians had never used a computer before. Even those who had were often unfamiliar with a graphical windows-based interface. Additional training staff was required to address this need.

Once trained, many physicians became avid users, to the extent that usage-based ISDN charges exceeded $300/month for several offices. We have negotiated a flat-rate pricing with the local phone company to address this issue.

Some of the greatest challenges were based in community and ethnic cultural issues. As is often the case, community physicians tend to look upon large academic medical centers with some degree of suspicion. For instance, some could not understand why CPMC would provide free computers (without having a dishonorable ulterior motive). Some suspected that the entire project was a way for CPMC to steal their patients. These issues were addressed in several ways. First, a physician at CPMC, who was known and respected by the local community physicians, acted as liaison. Second, it was critical to clearly explain the motivations and goals of the project. Third, since the CPMC data repository tracks all accesses to patient data, community physicians were told they could find out who had looked at their patients' data. These measures provided some level of reassurance. Another issue resulted from lack of sensitivity to Latin cultural etiquette. For many of the community physicians, it was considered poor manners to refuse a gift from a

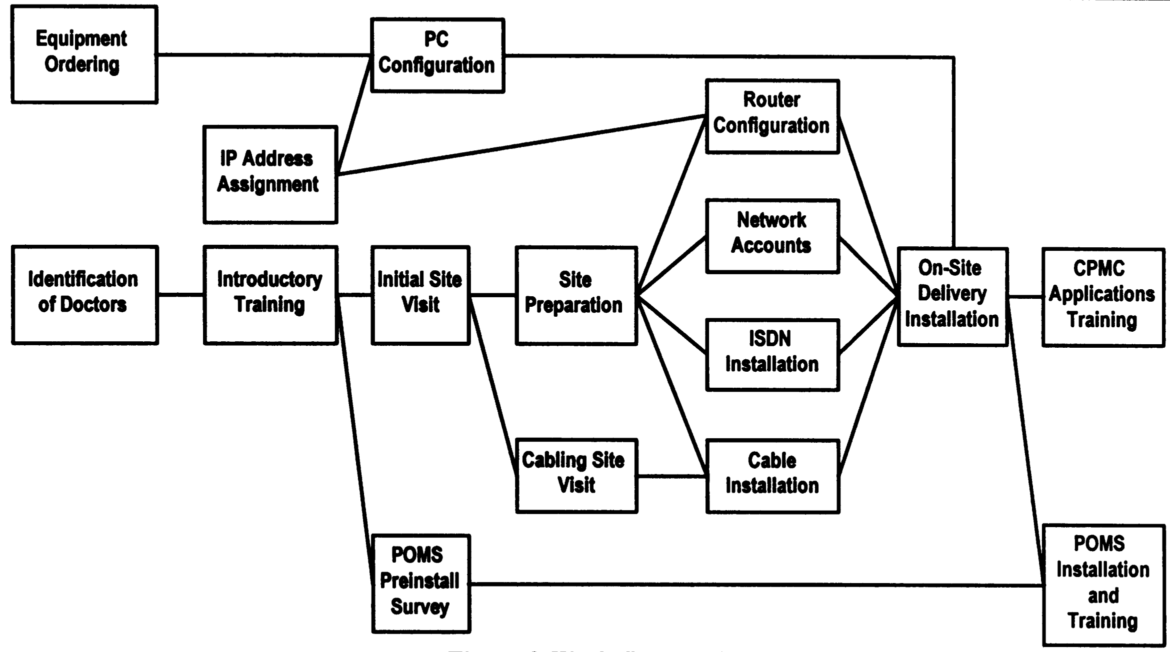

Figure 2-Work-flow Model

community leader such as our liaison physician. As a result, physicians who were not really interested in the project had difficulty stating so. This resulted in confusion and frustration between project staff and the physicians. The work-flow was modified to allow physicians a way to avoid participation while "saving face".

WORK-FLOW MODEL

In order to address the issues encountered early in the project, a work-flow model was developed (Figure 2) to assist in later installations. This model emphasizes the preliminary work required to prepare both the physical locations and the participants for the project. Steps in the model are discussed below.

Identification of doctors

The first step is to identify a candidate group of physicians. We identified practitioners from primary care, family practice and ob-gyn specialties through a variety of channels including hospital affiliated community physicians, the phone book, and personal recommendations. A letter was sent to these community physicians explaining the objectives of the project and inquiring about their interest in participation. Interested physicians were invited for an informational meeting about the nature of the project, its objectives, and a demonstration of the technology to be provided. Each implementation step was explained in detail, with particular emphasis on steps in which physician participation was critical, such as the Site Preparation and Training steps. Attention was drawn to the time commitment required. Based on this meeting physicians decided whether to participate.

Equipment Ordering

The ordering of equipment can proceed while participating physicians are identified. In addition to PCs and a printer, each community office requires network "patch" cables, a 4-port hub, an ISDN router, power strips, a conventional modem (used for electronic billing by the POMS), and a tape backup unit. The PCs and the printer are connected through the hub to form a LAN. The hub is connected to the ISDN router in a physician's office, which connects to a CPMC network router configured with an ISDN BRI board.

Introductory Training

Interested physicians are required to attend introductory training before installation begins. During the training, physicians receive hands-on experience with a windows GUI and the various applications. Physicians gain a better understanding of the commitment required and the role of CPMC in the project. Physicians who do not complete this training or remain enthusiastic are allowed to withdraw from participation.

IP Address Assignment and PC Configuration

The packet routing and filtering requirements involved in ISDN connections to the CPMC network made it impossible to use dynamic addressing. Addresses were reserved and assigned manually, and related location information was entered into the CPMC name server. When the hardware arrived, the PCs were set up and software was installed and configured at CPMC. Problems encountered during setup and "burn-in" were corrected prior to installation in community physician offices.

POMS Preinstall Survey

The Physician Office Management System is customized to each physician's practice, based on a 14-page survey. Customization is done by the POMS vendor. This can be completed early in the work-flow, but getting the physicians to complete the 14-page survey was an identified hurdle.

Initial Site Visit

The installation process starts with a Site Visit to evaluate the physical upgrades needed to accommodate the computer equipment. Many of the physicians' offices are situated in buildings that date from the first part of the century and lack sufficient space or electrical standards.

A suitable approach is to simulate space requirements by the use of cardboard boxes that are approximately the same size as the actual equipment. In some cases, counters needed to be cut away, or new tables purchased. Also, a location for the router and the hub needed to be identified. These require electrical connections but should not be in an easy to reach location. Ideally, agreed upon hardware placement should not be subject to change. Once the positions of the hardware components are decided, signs can be placed on the wall to indicate the intended location of the ISDN line outlet, Ethernet patch cable outlets, and any needed electrical outlets. This reduces confusion during actual installation by the phone company, network cabling contractors, and electricians.

The electrical connections deserve special mention. Because non-technical physicians' office staff usually acts as the intermediary between the project staff and any needed electrical contractor, it is helpful to put the electrical requirements in writing, including amperage, grounding and number of receptacles.

Cabling Site Visit

The characteristics of the network cabling must exactly match those of the computer equipment.[4] Therefore, close communication between the cabling contractor and the technical staff is critical. To simplify this communication we hired the same cabling company that CPMC uses for its wiring needs. The cabling company performs its own site visit to evaluate the physician's office.

Site Preparation

This step involves upgrading the infrastructure of the physicians office (i.e. electrical, furniture, etc.). We have found that this is a pivotal step in the process, and also the most variable. Some offices were "computer ready" while others required multiple changes. Although activities like cabling could theoretically occur simultaneously with the site preparation, this is potentially problematic. In spite of a careful initial Site Visit, the location of equipment must sometimes be changed during the site preparation process. This may occur either because requested office changes are not feasible for unforeseen reasons, or because on further reflection, the physician decides that a different location or configuration is preferable. For this reason, all other on-site work is delayed until the site preparation is complete.

Router Configuration

Configuration of the ISDN routers can be somewhat complex due to data vs. voice channel options, "B" channel threshold settings, line drop configuration, and network protocols utilized. The standard ISDN service consists of two 64 Kb/sec "B" channels. The router initially only opens one "B" channel and then opens the second channel only if bandwidth needs demand it. The router also determines when to close the channels when there is no traffic. Because the first minutes of a call cost more than later minutes, optimizing the channel parameters requires considerable trial and error. Network protocol is also important. "Chatty" protocols with a high overhead, such as IPX, do not work well over ISDN compared to more streamlined protocols, such as TCP/IP. We configured routers to filter on both the network packet source and protocol.

Network Accounts

The CPMC network administrators assign accounts to community physicians. Network accounts are assigned at this point so that when the on-site installation is complete the physician is immediately able to logon to the system. A problematic issue here involves the granting of CPMC information system privileges to non-CPMC physicians. A special security policy exemption was obtained for participants in this demonstration project.

ISDN Installation

In general, it was desirable to withhold ISDN line orders until after the Site Preparation step, in order to avoid later relocation of the line. However, project staff must also take into account potential delays in ISDN line installation by the phone company and order accordingly. In most telephone companies, ISDN service is handled by a group separate from standard services. This can result in considerable confusion when calls are placed for help, since standard services know little about ISDN. In order to simplify communication and reduce errors, it may be preferable to get a single representative from the telephone company to work with the project team on ISDN installs, a goal we have been unable to realize.

Cable Installation
We utilized a contractor to install network cabling appropriate to establish a LAN between the two PCs, the network addressable printer, and the router in each office. Miscommunication about office hours and misunderstanding about the nature of the contractor's work sometimes led to problems with the completion of this task.

On-Site Delivery and Installation
When the office is prepared with appropriate furniture, electrical outlets, an ISDN line, and cabling, CPMC personnel do the delivery and the installation of computer hardware. At this time, any final configurations in the PCs and router are made. After the installation is completed and tested, the physician is given the network account and is able to logon to CPMC network resources for the first time.

CPMC Applications Training
An appointment is set with the physician for additional training on how to use the various applications and the system in general. Several such sessions are required in order to accommodate user needs as their expertise grows. Training sessions were also a time when subtle system configuration problems were discovered.

POMS Installation and Training
After the computers are installed and operational, staff from the POMS vendor install and configure that system. Numerous trials were required to develop a configuration of the POMS that was compatible with WHICHIS systems and software for networking. Whenever two separate groups of support staff must cooperate in maintaining a system, it is possible that servicing one application will disable another. To minimize this, a test protocol was developed that allows either support staff to test all of the applications on the system.

CONCLUSION

This paper discusses a work-flow framework for, and problems encountered during, connecting unaffiliated private physician offices for a CHIN project. The work-flow plan tasks identified above should be applicable to other sites with similar connectivity goals.

Implementing a workable and efficient ISDN router configuration can be a challenge, as can designing a LAN and WAN-savvy workstation that runs a required suite of applications without conflicts or exceptions. Notwithstanding, greater challenges are the non-technical ones, such as aging building infrastructure, community physician biases against a large academic medical center, miscommunications, and ethnic cultural misunderstandings, that can significantly impact and delay project deployment. Other challenges included operational costs (capital costs were covered by the grant), user training needs, and ongoing site support.

We conclude that careful planning, site preparation, and human communication are critical success factors towards achieving technical connectivity solutions during a CHIN implementation.

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